

## Periodic Trends – Revision questions

- 1) Which alkali metal belongs to the sixth period?
- 2) Which halogen belongs to the fourth period?
- 3) What element is in the fifth period and the eleventh group?
- 4) Why do all the members of a group have similar properties?
- 5) For each of the following pairs, circle the atom or ion having the larger radius.
  - a. S or O
  - b. Ca or  $\text{Ca}^{2+}$
  - c.  $\text{Na}^{1+}$  or  $\text{K}^{1+}$
  - d. Na or K
  - e.  $\text{S}^{2-}$  or  $\text{O}^{2-}$
  - f. F or  $\text{F}^{1-}$
- 6) For each of the following pairs, identify the smaller ion.
  - a.  $\text{K}^{1+}$  or  $\text{Ca}^{2+}$
  - b.  $\text{F}^{1-}$  or  $\text{Cl}^{1-}$
  - c.  $\text{C}^{4+}$  or  $\text{C}^{4-}$
  - d.  $\text{S}^{2-}$  or  $\text{F}^{1-}$
  - e.  $\text{O}^{2-}$  or  $\text{F}^{1-}$
  - f.  $\text{Fe}^{2+}$  or  $\text{Fe}^{3+}$
- 7) In each of the following pairs, circle the species with the higher first ionization energy:  
(a) Li or Cs      (b)  $\text{Cl}^-$  or Ar      (c) Ca or Br      (d)  $\text{Na}^+$  or Ne      (e) B or Be
- 8) In each of the following pairs, circle the species with the larger atomic radius:  
(a) Mg or Ba      (b) S or  $\text{S}^{2-}$       (c)  $\text{Cu}^{+2}$  or Cu      (d) He or  $\text{H}^-$       (e) Na or Cl
- 9) Circle the best choice in each list:
  - (a) highest first ionization energy: C, N, Si
  - (b) largest radius:  $\text{S}^{2-}$ ,  $\text{Cl}^-$ , Cl
  - (c) highest electronegativity: As, Sn, S
  - (d) smallest atom: Na, Li, Be
  - (e) most paramagnetic: Fe, Co, Ni
  - (f) lowest first ionization energy: K, Na, Ca
- 10) Give two reasons for increasing atomic radius down a group on the periodic table.
- 11) Give two reasons for lower ionization energy going down a group on the periodic table.
- 12) Give two reasons for the increase in ionization energy going across a period from left to right.
- 13) Give two reasons for the decrease in atomic radius going across a period from left to right.
- 14) Explain why the second ionization energy for magnesium is lower than that for sodium.
- 15) Explain why the first ionization energy for boron is slightly less than that of magnesium.
- 16) Explain why the first ionization energy of oxygen is slightly less than that of nitrogen.
- 17) Describe the change in atomic radius when anions form.
- 18) Describe the change in atomic radius when cations form.

## Answers – Periodic Trends revision questions

1) Cs

2) Br

3) Ag

4) They have the same number of valence electrons

5) a.  $\boxed{S}$  or O c.  $Na^{1+}$  or  $\boxed{K^{1+}}$  e.  $\boxed{S^{2-}}$  or  $O^{2-}$   
 b.  $\boxed{Ca}$  or  $Ca^{2+}$  d. Na or  $\boxed{K}$  f. F or  $\boxed{F^{1-}}$

6)

a.  $K^{1+}$  or  $\boxed{Ca^{2+}}$  c.  $\boxed{C^{4+}}$  or  $C^{4-}$  e.  $O^{2-}$  or  $\boxed{F^{1-}}$   
 b.  $\boxed{F^{1-}}$  or  $Cl^{1-}$  d.  $S^{2-}$  or  $\boxed{F^{1-}}$  f.  $Fe^{2+}$  or  $\boxed{Fe^{3+}}$

7) (a) Li; (b) Ar (isoelectronic pair); (c) Br; (d)  $Na^{+}$  (isoelectronic pair); (e) Be (common exception)

8) (a) Ba; (b)  $S^{2-}$ ; (c) Cu; (d)  $H^{-}$  (isoelectronic pair); (e) Na.

9) (a) N; (b)  $S^{2-}$  ( $S^{2-}$  and  $Cl^{-}$  are isoelectronic); (c) S; (d) Be; (e) Fe (hint: determine no. of unpaired spins for each element); (f) K

10) Atomic radius increases going down a group because the electrons are added to energy levels that are farther from the nucleus and the outer electrons are shielded from the full attraction of the nucleus by the electrons in inner energy levels

11) Ionization energy decreases going down a group because the electrons are farther from the nucleus b/c they are added to outer energy levels. Furthermore the electrons are shielded from the full attraction of the nucleus by the electrons in inner energy levels

12) Ionization energy increases across a period because the electrons are closer to the nucleus and because there are more protons attracting the electrons. The electrons are closer to the nucleus because within a period, they are added to the same energy level at the same rate that protons are added to the nucleus which increases the attraction of the electrons to the nucleus and drawing them closer.

13) The atomic radius decreases because nuclear charge increases and electrons within a period are added to the same energy level. The increased nuclear charge pulls electrons closer – decreasing the radius.

14) Ionization energy generally increases across a period so this seems like an exception except that sodium only has one valence electron while magnesium has 2. Sodium only needs to lose one electron to have a stable noble gas configuration and once it loses it, it is very unwilling to give up a second electron. Magnesium, on the other hand, easily gives up its second electron since it needs to lose two to have the stable noble gas configuration. Second ionization energy refers to the energy it takes to remove an electron after one electron as already been removed.

15) Magnesium has two electron in the s sublevel while boron has two in the s sublevel and one in the p sublevel. Boron is more willing to give up its p than Mg is to give up one of its S electrons because there is some stability gained in having a filled sublevel.  $B\ 1s^2\ 2s^2\ 2p^1$   $Mg\ 1s^2\ 2s^2$

16) Ionization energy generally increases across a period so oxygen should have a higher ionization energy than nitrogen but it doesn't. If you look at the orbital diagrams for nitrogen and oxygen you will see that oxygen has one p orbital with two electrons and two other p orbitals with one electron each. The added repulsion from the two electrons in one orbital and the fact that there is some stability gained by having a half-filled sub-level, explains why it is easier to take an electron from oxygen than nitrogen. Nitrogen already has a half-filled sub-level.

17) When anions form, electrons are gained. The nucleus cannot overcome the added repulsion of the electrons and the radius increases. The more negative, the larger the ion.

18) When cations form, electrons are lost. With fewer electrons, there is less repulsion and the electrons are pulled closer to the nucleus. Therefore, for positive ions, radius decreases. The more positive, the smaller the ion.

Reference: *unknown*

<http://chemicalminds.wikispaces.com/>